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Chemical resistance of quartz over synthetic polycrystalline / monocrystalline sapphires for reproducibility

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HIGHLIGHTS

- Chemical resistance of quartz (glassware) is measured.
- Chemical resistance of synthetic polycrystalline/monocrystalline sapphires is measured.
- Tested chemicals include HCL, HNO_3, HF, HF/HNO_3, H_3PO_4, H_2SO_4, and NaOH.

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ABSTRACT

Reproducibility problems have delayed the advancement of Science. The chemical resistance of synthetic sapphires and quartz (glassware) was measured to quantize the dissolution of solid laboratory instruments. Glassware laboratory instruments have been used for many years in chemical/biomedical experiments. The choice of laboratory instruments is important for successful experiments since they may be dissolved in chemical. The chemical resistance is compared between synthetic polycrystalline sapphires, synthetic monocrystalline sapphire, and quartz (glassware) where tested chemicals include HCL, HNO_3, HF, HF/HNO_3, H_3PO_4, H_2SO_4, and NaOH respectively. For high reproducibility, the result suggests that we should use the high chemical resistant laboratory instruments including synthetic polycrystalline/monocrystalline sapphires, instead of glassware.

1. Introduction

Chemical resistance is an ability of solid materials to resist damage by chemical reactivity or solvent action according to answers.com. Laboratory instruments have to be wisely chosen by considering the chemical resistance of those [1]. The conventional laboratory instruments are largely made of glassware so that they may be dissolved in chemical [2,3]. In this paper, the chemical resistance of quartz (glassware), synthetic polycrystalline sapphires, and synthetic monocrystalline sapphire was measured respectively for comparison. Fig. 1 shows the measuring condition of the chemical resistance for tested synthetic sapphires and quartz (glassware). Tested chemicals include HCL, HNO_3, HF, HF/HNO_3, H_3PO_4, H_2SO_4, and NaOH. Tested piece of 1" x 1" x 0.2" synthetic sapphires and quartz were soaked in seven chemicals respectively for six days. Fig. 2 shows the chemical resistance of synthetic monocrystalline sapphire soaked in seven chemicals respectively. Fig. 3 depicts the chemical resistance comparison between quartz (glassware), synthetic polycrystalline sapphires (A479, A479H, A479ss, and A3479G), and synthetic monocrystalline sapphire soaked in HF, H_2SO_4, and NaOH respectively. Fig. 4 shows impurity of synthetic monocrystalline sapphire, pure Al_2O_3, synthetic polycrystalline sapphire A479ss, and synthetic polycrystalline sapphire A479 respectively where A479ss is the de facto standard synthetic polycrystalline sapphire in the current market. A479H and A479G are the special purpose synthetic polycrystalline sapphire where they are similar to A479ss. Synthetic sapphires show better chemical resistance than quartz (glassware) soaked especially in chemicals including sodium hydroxide and hydrofluoric acid. Synthetic monocrystalline sapphire shows better chemical resistance than polycrystalline sapphire in sodium hydroxide and hydrofluoric acid. Quartz (glassware) experiment reveals the significant

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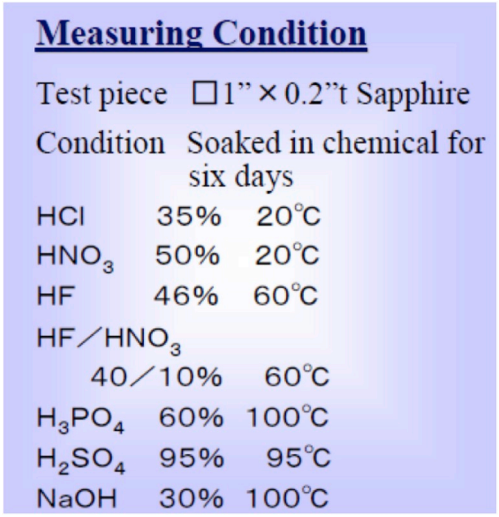

Fig. 1. Measuring condition of the chemical resistance for tested synthetic sapphires.

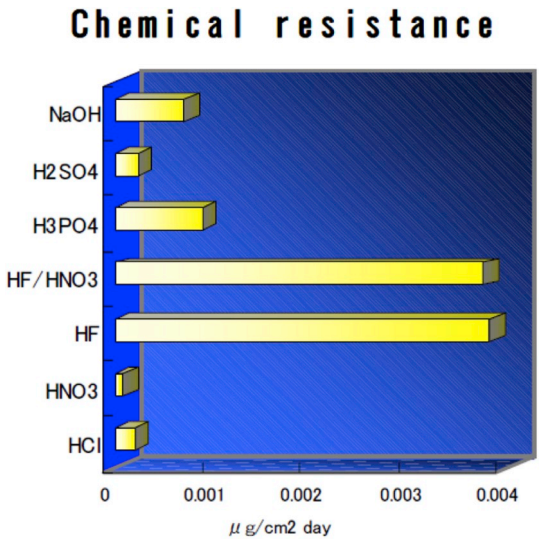

Fig. 2. Chemical resistance of synthetic monocrystalline sapphire soaked in seven chemicals.

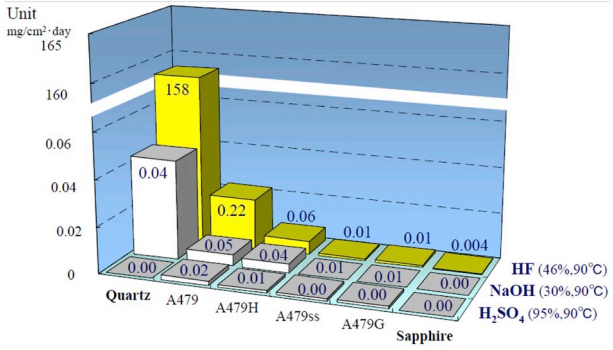

Fig. 3. Chemical resistance comparison between quartz, synthetic polycrystalline sapphires (A479, A479H, A479ss, A479G), and synthetic monocrystalline sapphire.

	MAJOR	COMPONENT/ PURITY	Si	Na	Mg	Ca	Fe	OTHERS
Sapphler	Al_2O_3	99.99 wt%	15	1	3	2	3	0 0 1 – 0 (S)5
Pure Al_2O_3	Al_2O_3	99.98 wt%	10	40	5	40	40	–
A479ss	Al_2O_3	99.5 wt%	100	100	1700	150	140	(Ti)30 –
A479	Al_2O_3	99 wt%	4000	< 150	150	150	< 350	–

Fig. 4. Impurity of synthetic monocrystalline sapphire, pure Al_2O_3, A479ss, A479.

amount of dissolution when it is soaked in sodium hydroxide or hydrofluoric acid.

2. Conclusion

This paper characterizes the chemical resistance of synthetic polycrystalline and monocrystalline sapphires, and quartz for comparison. A significant amount of dissolution from quartz (glassware) soaked in sodium hydroxide and hydrofluoric acid respectively was confirmed. This result suggests us to use the monocrystalline sapphire in the sensitive chemical experiments instead of glassware for high reproducibility.

Declaration of competing interest

We have no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.matchemphys.2019.122486.

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